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(54) IMPROVEMENTS IN OR RELATING TO WIRES

(71) We, CREUSOT-LOIRE, a French corporate body of 5 Rue de Monttessuy, Paris 7, France, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to wires formed from certain austeno-ferritic steels, such wires being suitable for use as support wires in liquid or gaseous hydrocarbon wells.

At the bottom of natural gas or oil wells certain tools for working or production operations are suspended from wires which can reach 6,000 metres or even more in length, and which have a very small diameter, e.g. between 2 and 5 mm. These wires, forming lowering lines, are subjected to conditions which are excessively severe and corrosive.

The very severe conditions are due to a number of factors including: the actual weight of the wire, e.g. 200 kg for a 6,000 m line; the weight of the tools; the temperature at the bottom, which can reach 130°C to 160°C; and the friction between the wire and the winch guide wheels.

Wires forming lowering lines must therefore have high mechanical strength, e.g. a tensile strength greater than 150 daN/mm^2, and good stress corrosion resistance, since the corrosive conditions in natural gas or oil wells are particularly severe. Thus, for example, natural gas wells in the south-west of France have an atmosphere including 5—17% hydrogen sulphide, 2—10% carbon dioxide, and aqueous chlorinated solutions containing up to 300 grams of sodium chloride per litre. The pressure of such atmospheres may reach 650 bars.

Known wires, in current use, are of two types:

a) of austenitic stainless steels,

b) of carbon steels surface-coated with a thin layer of nickel. In the atmosphere described above, known austenitic stainless steels do not last beyond an average of 30 descents, and in no case beyond 70 descents, whilst carbon steels surface-coated with a thin layer of nickel do not last on average for more than 60 descents. Both known types of wire are destroyed by corrosion in various ways, often following distortion of their initially circular section as they pass through guide wheels which follow the pay-out winch, and generally by stress corrosion.

This mediocre performance of known wires has two disadvantages:

a) when they are changed before breakage, the cost per descent is raised,

b) very often, they break while in use before their routine replacement, which occasions loss of or damage to expensive tools, and sometimes the at least partial stoppage of the well. It is this second disadvantage which is the more inconvenient in practice.

We have now found that wires formed of certain austeno-ferritic steels have high strength and good resistance to corrosion under stress, and are thus suitable for use as support wires in wells.

According to the present invention there is provided a wire formed from a steel with an austeno-ferritic structure and a ferrite content of between 15% and 40%.

The invention also includes a braided cable formed of a plurality of wires according to the invention.

In accordance with a preferred embodiment of the invention, the steel of which the wire is formed consists of:

C: less than 0.1%
Cr=16% to 27%
Ni=5% to 12%
Mo=0 to 5%
Cu+W+V: 0 to 6% in total, the content of each of the 3 elements, separately, being 0 to 4%
Si: less than 4%
Mn: less than 10%

the balance being iron and unavoidable impurities.

Preferably, the steel consists of:

C: up to 0.06%
Cr=19% to 22%
Ni=7% to 9%
Mo=2% to 3%
Cu: less than 2%
Si: less than 1%
Mn: less than 2%

the balance being iron and unavoidable impurities.

A particularly favourable steel has the composition:

C=0.02%
Cr=20.5%
Ni=8%
Mo=2.5%
Cu=1.5%
Si=0.5%
Mn=1.0%

the balance being iron and unavoidable impurities, and a ferrite content of approximately 30%.

Preferred wires according to the invention have a strength in excess of 150 da N/mm^2.

The wires of the invention are preferably obtained by drawing from a machine wire which has been fully annealed at about 1150°C, then quenched and chemically pickled. Preferably, the wires are coated with polytetrafluoroethylene before drawing.

In accordance with another preferred embodiment of the invention, the wires are subjected to a surface-hardening treatment, such as carburization, or nitridation, e.g. in an ammonia atmosphere.

The presence of ferrite in a mixed austeno-ferritic structure has the effect of stopping the propagation of a corrosion fissure starting from an austenite zone. In the wires according to the invention a composite structure of alternating fibres of ferrite and austenite is present. In such a structure, the development of corrosion fissures under stress is particularly difficult. The mixed austeno-ferritic structure therefore has marked superiority over the austenitic structures of the stainless steels usually used for these lowering lines.

Wires which, in addition, have undergone a surface-hardening treatment have the additional advantage of having a greater resistance to distortion of their circular section as they pass under tension over guide wheels.

In order to provide a better understanding of the invention, an embodiment of a wire in accordance with the invention is described below as a non-limiting example, together with the results which can be obtained with it.

This embodiment relates to a wire 6,820 metres long and 2.33 mm in diameter, which can resist corrosion under tension in a natural gas well laden with hydrogen sulphide.

Figure 1 shows a typical winching arrangement. Wire 2 is wound under tension in contiguous turns such as 3, on the drum of winch 1. Care is taken to ensure correct lubrication, to prevent any damage to the wire during unwinding. The winch is operated by a motor 4. It has a hand brake 5, a hand clutch 6, a hand accelerator 7, a clutch pedal 8, an accelerator pedal 9 and a gear change lever 10. In addition, an apparatus 11 enables the tension of the wire to be continuously measured, while a counter 12 measures the length of wire unwound. At the output of the winch, wire 2 is guided by pulleys 13.

Figure 2 shows the path of the wire from the winch to the well.

At the output of the winch positioned in vehicle 14, wire 2 passes over guide and return wheels such as 15 and 16, before being introduced into the well via an air-lock tube 18, which is provided in its upper portion with a special stuffing-box 19 which ensures tightness.

In the air-lock tube are attached to the end of the wire:

—the apparatus to be used,

—bars, the weight of which enables the resistances of pressure and friction at right-angles to the stuffing-box to be overcome,

—optionally, a slide which, by rapid movements of the wire,enables shocks to be applied to free tools or break shearing pins.

When the well-head air-lock tube has been closed, a pressure equal to that in the well is introduced into the air-lock tube.

The well-head valves can then be opened to allow the line to descend freely.

From this moment, all operations are carried out from the winch, while watching the indications of the measuring instruments (tension and length).

A wire suitable for this application is produced from a machine wire 5.5 mm in diameter, made of steel having the following composition:

X 2 COL
C=0.021%
Cr=20.6%
Ni=8.0%
Mo=2.4%
Cu=1.5%
Si=0.5%
Mn=1.1%

the balance being from and unavoidable impurities.

The machine wire is fully annealed at 1150°C in a neutral atmosphere, then quenched and pickled, coated on the outside with polytetrafluoroethylene and drawn without intermediate reheating to a diameter of 2.33 mm, which represents a cold-drawing of 82%.

The wire is then wound on a reel like a cable, by division into lengths, for use on the control winch 1. Progressively as the winch pays out the wire passes over the guide and return pulleys and wheels described above. Such a wire enables more than 120 descents to be made, i.e. 2 to 4 times more than the previously known wires, small risk of premature breakage. The strength of the wire in accordance with this example is 164 kg/mm².

WHAT WE CLAIM IS: —

1. A wire formed from a steel with an austeno-ferritic structure and a ferrite content of between 15% and 40%.

2. A wire as claimed in claim 1, in which the steel has a ferrite content of approximately 30%.

3. A wire as claimed in claim 1 or 2, in which the steel consists of:

C—less than 0.1%
Cr—16% to 27%
Ni—5% to 12%
Mo—0 to 5%
Cu+W+V—0% to 6% in total, with Cu 0 to 4%
W 0 to 4%
and V 0 to 4%
Si—less than 4%
Mn—less than 10%

the balance being iron and unavoidable impurities.

4. A wire as claimed in claim 3, in which the steel consists of:

C—up to 0.06%
Cr—19% to 22%
Ni—7% to 9%
Mo—2% to 3%
Cu—less than 2%
Si—less than 1%
Mn—less than 2%

the balance being iron and unavoidable impurities.

5. A wire as claimed in any of claims 1 to 4, in which the steel consists of:

C=0.02%
Cr=20.5%
Ni=8%
Mo=2.5%
Cu=1.5%
Si=0.5%
Mn=1.0%

the balance being iron and unavoidable impurities, and has a ferrite content of approximately 30%.

6. A wire as claimed in any preceding claim having a strength in excess of 150 daN/mm².

7. A wire as claimed in any preceding claim which has been formed by drawing a wire which has been fully annealed at approximately 1150°C, quenched, and chemically pickled.

8. A wire as claimed in any preceding claim which has been formed by drawing a wire coated with P.T.F.E.

9. A wire as claimed in any preceding claim which is surface-hardened.

10. A wire as claimed in claim 9, in which the surface hardening has been effected by carburization.

11. A wire as claimed in claim 9, in which the surface hardening has been effected by nitriding.

12. A wire as claimed in claim 11, in which the nitriding is effected in an atmosphere of ammonia.

13. A wire as claimed in claim 1, substantially as herein described.

14. A braided cable formed of a plurality of wires as claimed in any preceding claim.

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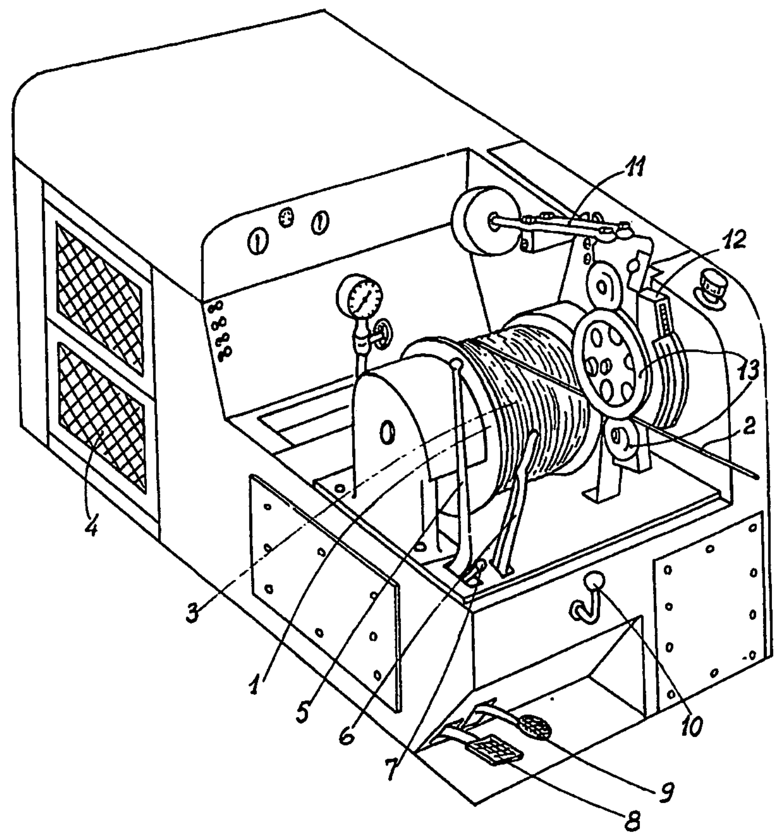

FIG: 1

1424458 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

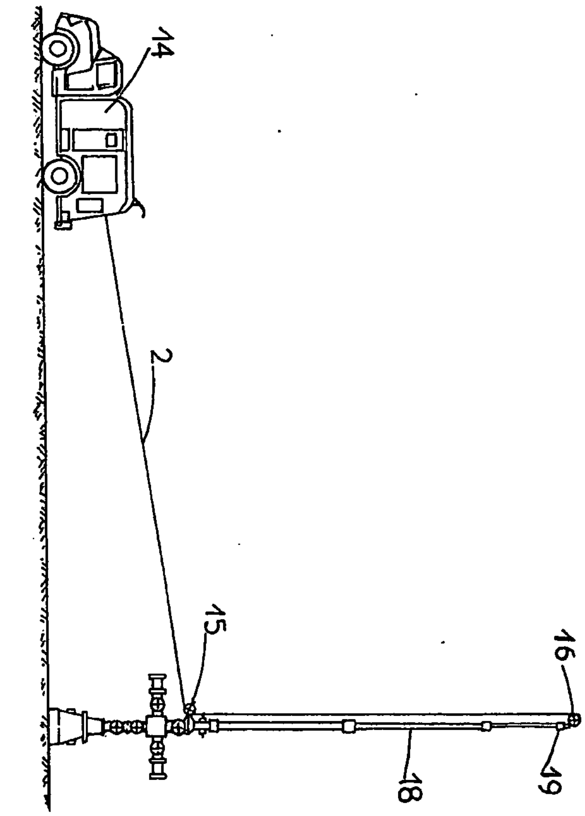

FIG: 2